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THE CAUSES OF DEATH IN DIABETES.¹

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WITH the lapse of years the conviction has grown upon me that the life of a diabetic patient might be prolonged and that coma was an avoidable accident, and yet I know of no cure for diabetes and I claim no patient cured. The results of the investigations conducted with Professor Benedict at the Carnegie Laboratory upon the utilization of carbohydrate in diabetes, and reported here last spring,² greatly strengthened that belief, for they proved that even the severest diabetic retained some power to burn carbohydrate. Then, too, in these last few months I have been unable to find any uncomplicated case of diabetes of long or short duration which has failed ultimately to show at least a small positive carbohydrate tolerance. The simultaneous observations of the Russell Sage Laboratory at Bellevue Hospital and the Carnegie Nutrition Laboratory showing that the respiratory quotients of severe diabetic patients rise following a prolonged fast, although not fully explained, are encouraging. And, finally, I must acknowledge that the fact that under simple prolonged fasting treatment no death from diabetes occurred among my patients at the New England Deaconess' Hospital for 350 days, has deepened the impression above expressed.

¹ Delivered at New York Academy of Medicine, December 21, 1915.

² Harvey Lecture, Delivered March 13, 1915. Also published in Arch. Int. Med., 1915, xvi, 693.

with fasting treatment show that in the presence of an infection a diabetic becomes sugar-free very slowly. An infection is an additional load for the diabetic to carry, and to it he often succumbs. If those cases are excluded in which coma was an element the number of deaths from infections is comparatively small, for there were but 36 cases. Of general infections, pneumonia heads the list with 15 deaths and influenza claims 3. Of local infections, septic and gangrenous legs account for 9, carbuncles for 4, and acute fulminating appendicitis for 2.

Thus far we have accounted for 147 deaths. Of this number it is problematical how many could be saved today. Perhaps one death from suicide could be prevented, a little could be accomplished for the cancer cases, the diseases might be arrested in a few and life prolonged in most of the tuberculous, but how effective modern treatment would be upon cardiorenal and vascular conditions in diabetes time alone will tell. But the majority of my diabetics died from another cause, and now let us face it.

B. DEATHS WITH COMA. Coma was fatal to 273 of my cases (64.24 per cent.), thus causing two-thirds of the deaths. During the last fourteen years there have been treated under my personal supervision in hospitals, 273 cases of diabetes, of which 15 have died of coma, making my total deaths in hospitals for this period 17. For many years my attitude toward coma was to consider it the culmination of the diabetes, and after the death of the comatose patient I could honestly unite with the family, the physician, and the nurse in the feeling that no more could have been done. But for me this comfortable creed has passed, and in its place has come the opinion that coma by no means represents the culmination of the disease, that it is not a justifiable accident, and though not in all, yet in most cases it is avoidable. My conception of coma in diabetes cannot better be expressed than by quoting from the charming essay of Moynihan on "Inaugural Symptoms in Abdominal Emergencies with Especial Reference to Duodenal Ulcer," only I shall change the word "ulcer" and the phrase "in the abdomen" to "diabetes," and the word "perforation" to "coma."

With the wording thus changed the text would read: "It is in dealing with the acute catastrophes occurring in *diabetes* that we shall probably derive the most instant and striking advantage from an attentive study of inaugural symptoms. To take a specific example, the onset of *coma in diabetes*. But let me first say that a catastrophe of this kind is almost always capable of being fore stalled. Though the onset of *coma in diabetes* is acute the *diabetes* itself is chronic. It is a disease that has existed for months or years and it has given, in almost every instance, not only sustained evidence of its existence, but a recent warning that the pathological processes engaged in it were becoming more acute. The warning, however, is commonly ignored, because the significance and import-

ance of it are not understood, and accordingly a disaster is precipitated. There are few catastrophes occurring in diabetes that are veritably acute."

Bearing this point of view in mind, may I analyze for you the deaths from coma which have occurred in my practice?

1. *Ether Anesthesia.* Case No. 729, a severe diabetic, three months after her last visit to me, without my knowledge, was taken to a dentist's office, given ether by her physician, and all her teeth extracted. This was on a Monday. She was taken home, became unconscious Wednesday, and died on Friday. I cannot force myself to believe that her death represented the culmination of diabetes, or was even accidental. Case No. 348, before an operation for removal of a prostate, was free from acid and sugar and tolerated 20 grams of carbohydrate. After light etherization followed by fasting, 33 and 41 grams of sugar appeared in the urine on the second and third day of the fast respectively and the ammonia was 3.3 grams. It is true that he recovered, just as all but 6 of 26 patients under my supervision who have had major operations have also done, but the ether lowered his tolerance and made his diabetes temporarily worse. This does not mean that diabetics should not be operated upon, but it demonstrates that ether anesthesia is a burden which a light case of diabetes may easily bear, which may change a moderate to a severe case, and to a severe case may be fatal.

2. *Impaired Kidneys.* Diabetic patients with vulnerable kidneys are peculiarly susceptible to coma because the power of elimination of acid bodies is impaired. You all will recall cases of Bright's disease in diabetes in which an apparently mild acidosis preceded coma. Years ago, Goodall³ and I pointed out that acidosis was much more easily tolerated by the young than the old diabetics, and this can well be attributed to the deficient kidneys of the latter. Few could void on the verge of coma the five or more liters of urine which with the old alkaline treatment was necessary for recovery, and is recorded to have taken place in those patients who did recover. Coma by no means is confined to the young: thus the percentage of coma in my fatal cases under fifty-one was 67 per cent, and above that age 33 per cent. I could specify several instances of this type and in this group might well be classed a few of the cases of death in pregnant women.

3. *Infections.* Already attention has been called to the fact that an infectious process renders the diabetes more severe. A considerable percentage of the cases of coma occurred in connection with either general or local infectious processes. It not infrequently happens that the infection is not recognized. Better statistics

³ The Clinical Value of the Estimation of Ammonia in Diabetes, Boston Med. and Surg. Jour., 1908, civiii, 646.

upon this point and in general about the circumstances attending coma should be accumulated. Thus, Case No. 836, seen in consultation one evening, was found to be in partial coma, but I was able to demonstrate to the physician a membrane in the throat, and three hours after the patient's death the following morning, the Board of Health reported a positive culture for diphtheria.

But what I consider of far more importance is the number of procrastinating cases of mild infections in mild diabetics, chiefly in their lower extremities, which frequently prove fatal. The youngest case of sepsis or gangrene of the legs in a diabetic in my personal experience has been fifty years. In other words, these conditions develop at a time of life when diabetes is mild, and why should they so frequently be fatal? Consider with what these mild cases of diabetes have to contend. Handicapped by a lingering infection, which only too often is allowed to continue for months, with kidneys less efficient for throwing off the acidosis attack, deprived of exercise—that recently proven stimulus to sugar consumption (for whoever heard of a poor, old, gangrenous diabetic taking exercise)—these pitiful patients frequently meet a fourth enemy in ether anesthesia; and is it any wonder that a formerly innocent disease becomes virulent and the victim dies of coma? There is no doubt in my mind but that if such cases had been treated vigorously, even with the dietetic methods of a few years ago, a large percentage of the legs amputated might have been saved. In fact, Dr. Stettin has most ably demonstrated this. If one will read his paper it will be seen that his success in these cases was due to two factors: (1) that his patients were given the very best medical treatment of the time, and (2) that they had the advantage of expert surgical care. It is known that if a diabetic patient has gall-stones to be removed he instantly commands the services of the leading surgeon on the senior staff; but if a diabetic patient has a sore toe there is no house officer too young to dress it, until a few weeks later, if the patient survives that long, the surgeon in the amphitheatre amputates the thigh. I recommend to your careful perusal Dr. Stettin's article.⁴ Any success that I have had with surgical patients in diabetes has been due to the fact that I know no surgery, and learned that never-to-be-forgotten lesson twenty-one years ago; and, further, that no matter how trivial the ailment I have secured the very best surgical skill for my patients.

4. *Mental Excitement.* An occasional case of coma is precipitated in a severe diabetic by mental excitement. A violent fit of anger in one of the hospital patients, already in a precarious condition, was accompanied by vomiting and inability to retain liquids. Coma soon appeared, and this case I know to have been duplicated by another outside the hospital. A patient with exophthalmic goitre went into coma with far more ease than is the rule.

⁴ Jour. Amer. Med. Assn. 1913, ix, 1126.

5. *The Influence of a Fat-Protein Diet or Fat Poisoning.* The explanations of coma thus far given account for many deaths, but by no means for the majority of deaths from coma in diabetes. In these fourteen years at the hospital 9 cases of coma have occurred under my care which could not thus be explained. It is easy to say that the patients die soon after admission, but I cannot get around the thought that if a patient reaches the hospital alive I am responsible for his departure from the hospital alive, too. I will partly excuse myself for the death of one patient five hours after entrance and for a child of two years, who was in coma in ten hours, but I will not plead any excuse for the other 7 deaths. A study of these patients shows none of the factors hitherto mentioned as predisposing to coma, but there is one factor which is common to all, namely, the diet consisted largely of fat and protein with little carbohydrate, or just prior to entrance or after entrance an excessive quantity of fat had been given. Diabetic patients will live untreated for many years without the appearance of coma. They suffer from complication after complication. They are tormented with sepsis, neuritic pains, and pruritus; yet they still live. Their diet is atrocious. Along comes an enthusiastic young doctor—and years ago I could easily have been classed in that group—and presto! change! fat is increased, carbohydrate diminished, and the patient goes into coma. Out of carbohydrate it is impossible to form the acid bodies. When, therefore, carbohydrate is suddenly replaced with fat we deliberately furnish our diabetic patients with material which though it acts partly as a food, acts far more as a poison. At a recent meeting upon acidosis in children, Dr. Jacobi really struck a keynote. He said that prevention is the treatment of acidosis for children, and that those susceptible to acidosis ought not to have fat. What he said for children holds for diabetics. Diabetic patients need fat—it forms the chief constituent of their diet—but they must not be poisoned with it; they must be gradually accustomed to it.

The treatment of acidosis in the past has been unsatisfactory. Like typhoid fever, it should be prevented—not treated—and in uncomplicated cases this can be done. Although 90 per cent. of our diabetic patients will quickly and safely become sugar-free by simple fasting, for the remaining 10 per cent., which would include cases already showing acid poisoning, elderly patients and diabetics with infections, I suggest that prior to giving any fasting treatment a possible acidosis be anticipated by taking away the cause—namely, by the absolute exclusion of fat from the diet, but otherwise make no change in the diet or in the habits of the patient. After two days, or longer if desired, omit protein—another, though lesser contributing factor to acidosis—and thereupon daily halve the carbohydrate hitherto unchanged in the diet, until 10 grams are reached, and then proceed with routine fasting treatment. I would

welcome information as to whether such treatment fails to prevent the appearance of acidosis or to lessen an acidosis already existing. Your aid is solicited, for you must remember that under plain fasting 350 days intervened without a death in the hospital, and if this preliminary treatment to fasting is at all advantageous it will require some time to test its efficacy.

6. *Rapid Loss of Body Fluid.* Vomiting at the onset of coma usually presages death, because the patient is deprived of fluid with which to eliminate acids. Body liquids are so needed that the body in the course of coma becomes obviously dry. This is really only another cause for defective elimination.

But I have been interested for many years in the importance of salt for a diabetic. Recently, too, my attention was drawn by a patient to the fact that in another hospital he lost thirteen pounds during the first four days of fasting treatment. Inquiry developed that he was given, during this period, only water and alcohol. Had he been given broths or some mineral water, suffice it to say that during fasting, even for a week, he would probably have lost little or no weight. This is important, because patients prior to coma frequently lose weight rapidly. Thus in the presence of multiple carbuncles and septicemia one of my patients lost thirty-six pounds in eleven days preceding his death. Years ago in seeking for the cause of edema in a severe diabetic patient who was taking sodium bicarbonate I withdrew sodium chloride from his diet. Prompt loss of weight followed and symptoms of coma appeared. Since then I have been careful not to restrict salt, and I can well understand the opinion of Hodgson, that water rich in salts is really helpful to diabetic patients. On the other hand I would point out that large doses of sodium bicarbonate frequently are detrimental to a patient with threatening coma. How many patients have we had recover who took 20 teaspoonfuls of soda a day and a tablespoonful of whisky every hour and a half? For the last four months not one of my patients has been given a teaspoonful of sodium bicarbonate, and so far I have seen nothing but good results. I prefer to follow Dr. Jacobi's advice and prevent rather than to treat acidosis, and even when it appears I am inclined, though I hold myself ready to change my opinion any moment, to accept the advice of another master of medicine in New York, Prof. Herter, who in 1901 told me he preferred to let his diabetic patients neutralize their acidosis with their own ammonia rather than to give them sodium bicarbonate.

While seeking out the fatal cases of diabetes the number of living patients was ascertained. For comparison I have arranged both groups in decades and completed the average length of life of the fatal cases and the average duration of life of the living cases up to December 1, 1915. It is obvious that among the living cases will be found many in whom the disease is of recent origin, and for